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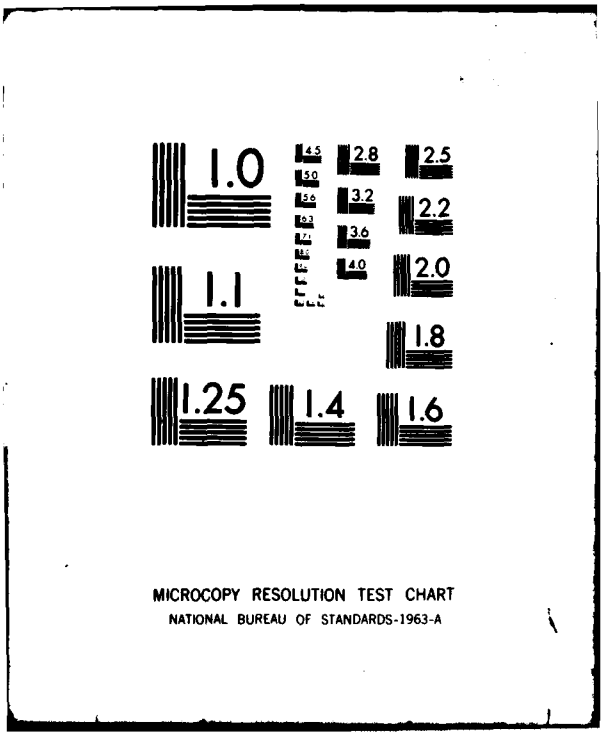
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COMBINATORIAL ALGORITHMS IN OPERATIONS RESEARCH

FINAL REPORT

T. C. HU

MARCH 10, 1980

U.S. ARMY RESEARCH OFFICE

DAAG29 76 G 0031

UNIVERSITY OF CALIFORNIA, SAN DIEGO
LA JOLLA, CA 92093

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SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: DAAG29 76 G 0031	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER: (9)	
4. TITLE (and Subtitle): (6) Combinatorial Algorithms in Operations Research	5. TYPE OF REPORT & PERIOD COVERED: Final Report 1 Sep 75 — 31 Dec 79
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): (10) T. C. Hu	8. CONTRACT OR GRANT NUMBER(s): (15) DAAG29-76-G-0031
9. PERFORMING ORGANIZATION NAME AND ADDRESS: University of California, San Diego, Dept. of Electrical Engineering & Computer Sciences, La Jolla, CA 92093	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: DD1473 (11) 10 Mar 80
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709	12. REPORT DATE: March 10, 1980
	13. NUMBER OF PAGES: 5 (12) 5
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): U.S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

(18) ARO (19) 12945-3-M

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

NA

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Binary Tree, Combinatorial Algorithm, Network

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Nine technical papers and a manuscript of a book on "Combinatorial Algorithms" were prepared during this period. The most significant discoveries are two algorithms of constructing binary tree optimum under various criteria. The first algorithm constructs optimum binary trees which include Huffman's tree as a special case. The second algorithm constructs optimum alphabetic trees which include Hu-Tucker tree as a special case.

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Foreword

The most important combinatorial algorithm in operations research is the Simplex Method. In fact, the different extensions of the Simplex Method and related later developments become the body of knowledge known as mathematical programming. Some standard reference books in mathematical programming are, "Linear Programming and Its Extensions" by Dantzig, "Flows in Networks" by Ford and Fulkerson, and "Integer Programming and Network Flows" by T. C. Hu.

However, many combinatorial algorithms are not related to the Simplex Method and they are widely used in operations research. For example, the back-track method (or branch-and-bound), the dynamic-programming-type algorithm, and various heuristic algorithms can all be classified under this category. The principal investigator has developed several such algorithms and prepared a book on combinatorial algorithms during the grant period.

Report

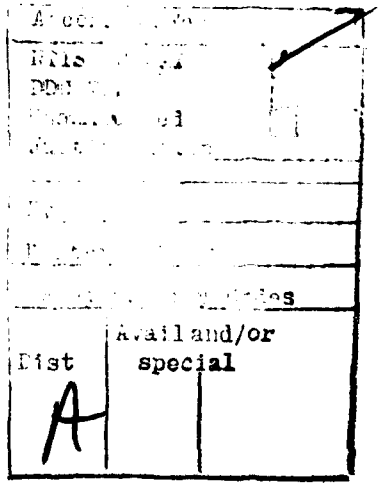
Nine technical papers [1-9] were prepared during the period. Following are some of the highlights of our work.

A well-known heuristic algorithm to solve a knapsack problem is called the greedy algorithm. Essentially, the algorithm puts into the knapsack, as many as possible, the most valuable items; then the second-most valuable items into the remaining space, etc. Magazine, Nemhauser and Trotter characterized the necessary and sufficient conditions for such a heuristic algorithm to work. He and Lenard [2] gave a simple proof. Hu and Tien [6] obtained the maximum error bound of the heuristic algorithm when it fails to give the optimum solution.

There are many optimum problems in binary trees. A famous algorithm to construct a binary tree was given by Huffman in 1952. If the leaves of the binary tree have to satisfy alphabetic constraints, then the Hu-Tucher algorithm must be used. In [7], Hu, Kleitman and Tamaki found a very general algorithm for constructing binary trees optimum under various criteria. The general algorithm is a simple modification of Huffman's algorithm and the Hu-Tucker algorithm.

An application of network-flow theory to distributed computing is given in [8]. A new concept of local min cut is given in [9].

My book will consist of eight chapters: 1. Shortest path. 2. Maximum flow. 3. Dynamic programming. 4. Backtrack. 5. Binary trees. 6. Heuristic algorithms. 7. Matrix-chain product. 8. NP-complete problems.



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